TITLE: Innovative Coal Solids-Flow Monitoring and Measurement Using Phase-Doppler and Particles Scattering Technique

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1. ABSTRACT

Fuel flow to individual burners is complicated and difficult to determine on coal fired boilers, since coal solids are transported in a gas suspension that is governed by the complex physics of two-phase flow. Total fuel flow to the pulverizer is usually indicated by the gravimetric feeders and air flow into the pulverizer is measured by flow venturies or by other methods. The flow of air and coal can be easily controlled by damper position and speed control of the feeders, respectively. However, the distribution of the inhomogeneous coal solids suspension is difficult and depends on a lot of variables.

In this paper, laser-based phase Doppler particle analyzer (PDPA) and particle image velocimetry (PIV) is used to measure the particle size and velocity. Design of experiment and analysis of variance is the efficient methods to identify significant factors of experiment. The purpose of the experiments is to measure the particle size and velocity and analyze them using statistical method to see which factor will affect particle performance.

Accomplishments Achieved During the Current Period of Performance:

The particle testing using the laser-based PIV was carefully prepared and conducted. To control the amount and rate of particles crossing the beams, the specially designed hopper system was used. The designed hopper is a simple, non-mechanical device using semi-transparent plastic material that offered an inexpensive, reliable powder dispensing solution. Powder is dispensed reliably and accurately. The flow rate is easily varied from a high rate to a trickle for accurate dispensing.

Five(5) different size groups of organic particles are tested and analyzed using analysis of variance (ANOVA) method. The groups of particles are less than 150 microns, between 150 microns and 250 microns, between 250 microns and 355 microns, and between 355 microns and 425 microns, between 425 microns and 500 microns. The open rate of control gate was

1/16 or 1/8. The particle flow section was 0 to 10 cm below the particle dispensing hopper system.

The particle velocity ranges were between -24.48 m/sec and 25.69 m/sec. According to the analysis of variance (ANOVA) method, particle size and interaction of particle size and flow rate have a significant effect on the lower limit of the particle velocity along with 95% of confidence rate. The particle velocities decreased when the observation range increased.

Plans for Remaining Period of Performance

- The small size range (less than 75 microns) of organic, marble, coal particles will be tested using the laser-based PIV system.
- The systematic testing for different particles will be continued under different testing conditions.
- The particle characteristics including mean diameter and mean velocity of the different particles will be continuously explored.
- The statistical methods including ANOVA will be used to analyze the factors effecting the mean diameter and mean velocity of the small size particles.

2.LIST OF PUBLISHED JOURNAL ARTICLES, COMPLETED PRESENTATIONS AND STUDENTS RECEIVING SUPPORT FROM THE GRANT:

Conference Presentations

1. Y. Huang and S. Lee, "The Advanced Instrumentation/Analysis on the Particle Characteristics Using Laser-Based Phase Doppler Particle Analyzer(PDPA)and Particle Image Velocimetry(PIV)" Published in the Proceedings of 12 th Annual International Conference on Industrial Engineering Theory, Applications and Practice, November 2007. pp.75-80.
2. Y.Huang and S. Lee, "Fuel Flow Simulation and fuel Characteristic Analysis in the Combustion System Using Statistical Method, Published in the Proceedings of American Society of Engineering Education (ASEE) Middle Atlantic Fall 2007 Conference, November 2007, CD-publication: C-2007.
3. F. John and S.Lee, "Using Laser-based Instrumentation to Give Students Experience in Advanced Instrumentation Technology", Published in the Proceedings of ASEE Middle Atlantic Fall 2007 Conference, November 2007, CD-publication:C-2007.

Students Supported Under the Grant

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